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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/696,989	10/30/2003	C. Brent Dane	MICI 1001-2	7873

22470 7590 06/08/2006

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EXAMINER
LANE, JEFFREY D

ART UNIT	PAPER NUMBER
2828	

DATE MAILED: 06/08/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary	Application No.	Applicant(s)	
	10/696,989	DANE ET AL.	
	Examiner	Art Unit	
	Jeffrey D. Lane	2828	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 17 February 2006.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-22,24-43 and 57-64 is/are pending in the application.

4a) Of the above claim(s) ___ is/are withdrawn from consideration.

5)☐ Claim(s) ___ is/are allowed.

6)☒ Claim(s) 1-22,24-43 and 57-64 is/are rejected.

7)☐ Claim(s) ___ is/are objected to.

8)☐ Claim(s) ___ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 17 February 2006 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ___.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date ~~10/30/03,05/26/04~~. 2/6/06 & 4/17/06
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ___ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: ___.

DETAILED ACTION

Note on Reference Citation

With non-patent literature the examiner is using the subject heading and numbering the paragraphs based on the subject headings. Starting at one after each heading. The line numbers also start at one with each paragraph. Paragraph and line numbers for non-patent literature do not restart at the beginning of each page. Patent literature is cited using the standard format. The examiner also is including some of the figures from the references with emphasis added for clarity and convenience.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-4, 6-15, 20, 22, 24-30, 35, and 38-40 are rejected under 35 U.S.C. 102(b) as being disclosed by Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction". IEE Journal of Quantum Electronics. Pg 148-163. Vol 31. No. 1. Jan. 1995)

As for claim 1, Dane discloses in figure 1, shown below, A method of operating a laser to obtain an output pulse of laser radiation having a single wavelength (see pg 150 II Optical Architecture: **D. Single Frequency Oscillator, 1st paragraph, lines 24-26 "The low power single frequency flux...")**, the laser including a resonator (**the resonator is being interpreted as being bound by the mirrors shown in the fig 1**

shown below, labeled as resonator) *with an output coupler* (in fig 1 it comprises a polarizer, labeled as polarizing beam splitter, and a Pockels cell, labeled as a Pockels cell), a gain medium (**labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2**) positioned inside the resonator and a pump source (see description of fig 5, a flash lamp is interpreted as a pump source), the method comprising: inducing an intracavity loss into the resonator (There is a loss in the resonator because there is no output a beam during the buildup stage) *by setting the reflectivity of the output coupler* (through polarization rotation, described on Pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19, "The <half wave> voltage is applied to the Pockels cell as the injected **seed** pulse is transmitted into the ring, canceling its passive 90 rotation … the Pockels cell voltage is switched back to zero … and is transmitted through the input polarizing beam splitter."), the loss being an amount that prevents oscillation during a time that energy from the pump source is being stored in the gain medium (see pg 151 II Optical Architecture: D. Single Frequency Oscillator, 2nd paragraph, lines 1-3, if there is no oscillation then there is a loss); building up gain with energy from the pump source in the gain medium until formation of a single-frequency relaxation oscillation pulse in the resonator (**see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, line19-26**); and reducing the intracavity loss induced in the resonator upon the detection of the relaxation oscillation pulse *by increasing the reflectivity of the output coupler,* (through polarization rotation, described on Pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19, "The <half wave> voltage

is applied to the Pockels cell as the injected **seed pulse** is transmitted into the ring, canceling its passive 90 rotation … the Pockels cell voltage is switched back to zero … and is transmitted through the input polarizing beam splitter."), so that built-up gain stored in the gain medium is output from the resonator as an output pulse at the single frequency (see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, lines 21-26).

As for claim 2, Dane discloses, " It <the gain medium> is composed of the neodymium (Nd) doped phosphate glass…" (Pg 151 III. Amplifier Design: A. Amplifier Slab, 1st paragraph, lines 3-4).

As for claim 3 and 4, Dane discloses in figure 5, shown below, wherein said pump source comprises a source of optical energy (see description of figure 5). A flash lamp is a source of optical energy.

As for claim 6, Dane discloses, " The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation, the Q-switch is opened. " (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph lines 21-24)

As for claim 7, Dane discloses, "When the Pockels cell voltage is switched back to zero, the injected pulse makes one more ring pass in s-polarization, corresponding to two more gain passes. The cell is therefore not required to transmit the fully amplified output pulse energy.... The amplified output pulse exits the system… " (Pg 150, II. Optical Architecture: B. Unidirectional Uncorrected Operation, 1st Paragraph lines 24-29)

As for claim 8, Dane discloses in figure 15b shown below, a ring laser that generates a plurality of output pulses having substantially constant pulse amplitude and

pulse width by repeating said inducing, building up and reducing steps. The examiner wishes to point out that this is shown because fig 15b is well defined. If the pulses were not substantially constant in amplitude or in pulse width they would not form a well-defined graph when superimposed.

As for claim 9, Dane discloses in fig. 1, shown below, a laser that has an output pulse with a single wavelength, a resonator a gain medium, a pump resource, a means to induce intracavity loss, and able to output the pulse. Dane further discloses, in fig 15a, also shown below, the output pulse has a pulse width of less than 30 nanoseconds, full-width half-maximum.

As for claim 10, Dane discloses, in figure 1, wherein the resonator includes an output coupler having a controllable reflectivity (a polarizer, labeled as a polarizing beam splitter in fig. 1), and includes controlling the reflectivity (through polarization through the Pockels cell, labeled as Pockels cell in fig 1) of output coupler to establish a desired pulse width.

As for claim 11, Dane further discloses, in figure 1, the resonator includes an output coupler comprising a polarizing beam splitter (labeled as polarizing beam splitter in figure 1), and includes controlling the reflectivity (through a Pockels cell to a polarizer) of output coupler by controlling polarization inside the resonator.

As for claim 12, Dane discloses in fig. 1, shown below, the resonator includes an output coupler comprising a polarizing beam splitter, and said inducing intracavity loss includes setting an amount of intracavity light that is transmitted by the polarizing beam splitter.

As for claim 13, Dane discloses in fig. 1, shown below, the resonator includes an output coupler comprising a polarizing beam splitter, and said inducing intracavity loss includes inserting a polarization rotation element (a Pockels cell) in the resonator to set an amount of light that is transmitted by the polarizing beam splitter.

As for claim 14, Dane discloses in fig. 1, shown below, the resonator includes an electronically controlled Pockels cell, and the resonator includes an output coupler comprising a polarizing beam splitter, and including controlling the reflectivity of output coupler by controlling polarization inside the resonator using the Pockels cell.

As for claim 15, Dane discloses in fig. 1, shown below, the resonator includes an electronically controlled Pockels cell (see pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph lines 16-19), and the resonator includes an output coupler comprising a polarizing beam splitter (labeled as polarizing beam splitter in fig 1), and including controlling the reflectivity of output coupler by controlling polarization inside the resonator using the Pockels cell (see pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph lines 16-19).

As for claim 20, Dane discloses in Fig. 1, shown below, wherein the resonator comprises a ring having an odd number of reflectors. The figure shows a resonator with 7 reflectors, numbering added to show how the Examiner is counting the reflectors.

As for claim 22, Dane discloses in Fig. 1, shown below, A laser system, comprising: a laser resonator (shown as resonator in fig 1 below), comprising an output coupler (labeled as a polarizing beam splitter) *with an adjustable reflectivity* (through polarization rotation, described on Pg 150, II. Optical Architecture: C. Operation With an

SBS Conjugator, 1st Paragraph); a Q-switch (labeled as a Pockels cell in fig 1) in the resonator; a gain medium (labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2) in the resonator; a source of energy (see description of fig 5, a flash lamp is interpreted as a source of energy), coupled with the gain medium, to pump the gain medium (see figure 5, shown below); a detector (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-23), coupled with the resonator, to detect oscillation energy in the resonator; and a controller, coupled to the source of energy, the Q-switch and the detector, to set *the adjustable reflectivity of the output coupler to establish* (through polarization rotation, described on Pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19) conditions inducing loss in the resonator at a level allowing build up of gain in the gain medium to produce a relaxation oscillation pulse, and to decrease loss in the resonator *by increasing the adjustable reflectivity of the output coupler,* (through polarization rotation, described on Pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19, "The <half wave> voltage is applied to the Pockels cell as the injected seed pulse is transmitted into the ring, canceling its passive 90 rotation … the Pockels cell voltage is switched back to zero … and is transmitted through the input polarizing beam splitter."), in response to detection of the relaxation oscillation pulse, so that an output pulse having a single frequency is generated **(described by Dane on Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-24, which reads " The intracavity power is**

monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation, the Q-switch is opened. ")

As for claim 24, Dane discloses in fig. 1, shown below, said output coupler comprises a polarizing beam splitter (labeled as polarizing beam splitter in fig 1).

As for claim 25, Dane discloses, "By placing a frequency selective element such as an etalon in the cavity, this long build up time and the corresponding many passes through the etalon results in single longitudinal mode oscillation " (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 18-21)

As for claim 26, see claim 25. The Examiner wishes to point out that a set does not necessitate having more than one.

As for claim 27, Dane discloses in fig. 1, shown below, wherein the Q-switch comprises a Pockels cell (labeled as a Pockels cell in fig 1), and the output coupler comprises a polarizing beam splitter (labeled as a polarizing beam splitter in fig 1).

As for claim 28, Dane discloses, "The 1053 nm transition in Nd:YLF closely matches the fluorescence curve peak in the Nd doped phosphate glass used in this amplifier system. "(Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 1-3)

As for claim 29, Dane discloses in figure 5, shown below, the pump source comprises a source of optical energy (see description of fig. 5). The Examiner wishes to point out that a flashlamp is optical energy.

As for claim 30, Dane discloses in figure 5, shown below, pump source comprises a flashlamp (see description of fig 5).

As for claim 35, Dane discloses in Fig. 1, shown below, wherein the resonator is arranged as an optical ring having an odd number of reflectors. The figure shows a resonator with 7 reflectors, numbering added to show how the Examiner is counting the reflectors.

As for claim 38, Dane discloses in Fig. 1, shown below, wherein the output coupler comprises a polarizing beam splitter (labeled as a polarizing beam splitter), and including a polarization rotation element (a Pockels cell, labeled as Pockels cell in the figure) in the resonator to set an amount of light that is transmitted by the polarizing beam splitter during build up of gain (see pg 151 II Optical Architecture: D. Single Frequency Oscillator, 2nd paragraph, lines 3-6).

As for claim 39, Dane discloses in Fig. 1, the output coupler comprises an output coupler having an adjustable reflectivity (through a Pockels cell, labeled as a Pockels Cell, to a polarizer, labeled as a polarizing beam splitter), and the controller sets an adjustable reflectivity of the output coupler to establish a pulse width.

As for claim 40, Dane discloses in Fig. 1, shown below, wherein the Q-switch comprises a Pockels cell, and the output coupler comprises a polarizing beam splitter, and the controller applies an adjustable voltage to the Pockels cell when reducing loss in the resonator, the adjustable voltage establishing an amount of reflectivity of the output coupler to establish a pulse width. Dane further discloses, "When the Pockels cell voltage is switched back to zero, the injected pulse makes one more ring pass in s-polarization, corresponding to two more gain passes. The cell is therefore not required to transmit the fully

amplified output pulse energy.... The amplified output pulse exits the system... " (Pg 150, II. Optical Architecture: B. Unidirectional Uncorrected Operation, 1st Paragraph)

Claim Rejections - 35 USC § 102-New Claims

3. Claims 34, 57-59, 62 and 63 rejected under 35 U.S.C. 102(b) as being anticipated by Hackel (US 5022033).

As for claim 34 Hackel discloses in figs 2&3, A laser system, comprising: a laser resonator 10, comprising an output coupler (M1, fig 2; M3 fig. 3) a Q-switch 20 in the resonator; a gain medium 12 in the resonator 10; a source of energy 15, coupled with the gain medium 12, to pump the gain medium 12; a detector, coupled with the resonator, to detect oscillation energy in the resonator (See 11/42-44); and a controller, coupled to the source of energy (See 6/3-5), the Q-switch and the detector, to set conditions inducing loss in the resonator at a level allowing build up of gain in the gain medium to produce a relaxation oscillation pulse, and to decrease loss in the resonator in response to detection of the relaxation oscillation pulse, so that an output pulse having a single frequency (See abstract) is generated, wherein the resonator is arranged as an optical ring, and including optical components in the resonator acting as an optical diode 30. Note: the arguments of against the original rejection of claim 34 are non persuasive and maintained (See 35 USC 103; and Response to Arguments)

As for claim 57, A method of operating a laser to obtain an output pulse of laser radiation having a single wavelength, the laser including a resonator configured as a ring 10, a gain medium 12 positioned inside the resonator and a pump source, the method comprising: inducing an intracavity loss into the resonator (See abstract), the

loss being an amount that prevents oscillation during a time that energy from a pump source is being stored in the gain medium; building up gain (See abstract) with energy from the pump source in the gain medium until formation of a single-frequency relaxation oscillation pulse in the resonator; and reducing the intracavity loss (See abstract) induced in the resonator upon the detection of the relaxation oscillation pulse so that built-up gain stored in the gain medium is output from the resonator as a output pulse at the single frequency; and suppressing oscillation in one direction in the ring: using components acting as an optical diode 16.

As for claims 58 and 62, Hackel discloses, restricting oscillation in the resonator to a single longitudinal mode using one or more etalons (18 both; 70 fig. 3) placed at or near normal incidence (Hackel discloses in figs. 2 and 3, the etalons approximately 90°, at or near normal)

As for claims 59 and 63, Hackel discloses, restricting oscillation in the resonator to a single longitudinal mode using one or more etalons (18 both; 70 fig. 3), and suppressing reflections from the one or more etalons (See 4/53-61).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 5 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Sokol (US 6,384,368).

As for claim 5, Dane discloses all that pertains to claim 1. However Dane does not disclose using a pump source comprising of a laser diode. Sokol discloses "there is a 100 to 1000 fold increase in laser processing cycles realized a diode laser pump over traditional flashlamp pumping." (Column 4 lines 15-17). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use a laser diode pump in Dane's ring laser to increase the life span of the pump source.

As for claim 31, Dane discloses all that pertains to claim 22. However Dane does not disclose using a pump source comprising of a laser diode. Sokol discloses "there is a 100 to 1000 fold increase in laser processing cycles realized a diode laser pump over traditional flashlamp pumping." (Column 4 lines 15-17). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use a laser diode pump in Dane's ring laser to increase the life span of the pump source.

6. Claims 16, 17, 18, 32, and 33 rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Ammann et al. (US 3,836,866).

As for claim 18, Dane discloses all that pertains to claim 1, as shown above. However Dane does not disclose using the onset to send the signal to the Q-Switch. Ammann discloses, "In general, however, there are pulse to pulse variations in the buildup time

due to laser mirror vibrations, pump lamp intensity fluctuations, etc. In accordance with this invention, we circumvent the instability problem by detecting the onset of relaxation oscillations and using this to trigger the opening of the Q-switch. " (Column 1 line 68 – Column 2 line 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use the detection onset of a relaxation pulse to send a signal to the Q-switch of Dane's ring laser.

As for claim 16 and 17, Dane in view of Ammann disclose detecting an onset of an oscillation pulse, as shown for claim 18. They do not disclose the value, i.e. a percentage of the oscillation peak power, at which an onset of an oscillation pulse is detected. It would have been obvious to one of ordinary skill in the art at the time of the invention to set the level of detection for the onset to less than 5% or to less than 1% of the peak power, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. *In re Aller, 105 USPQ 233.*

As for claim 32, Dane discloses all that pertains to claim 22, as shown above. However Dane does not disclose detecting the onset to send the signal to the Q-Switch. Ammann discloses, "In general, however, there are pulse to pulse variations in the buildup time due to laser mirror vibrations, pump lamp intensity fluctuations, etc. In accordance with this invention, we circumvent the instability problem by detecting the onset of relaxation oscillations and using this to trigger the opening of the Q-switch. " (Column 1 line 68 – Column 2 line 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the

invention to use the detection onset of a relaxation pulse to send a signal to the Q-switch of Dane's ring laser.

As for claim 33, Dane discloses all that pertains to claim 22, as shown above. However Dane does not disclose detecting the onset to send the signal to the Q-Switch. Ammann discloses, "In general, however, there are pulse to pulse variations in the buildup time due to laser mirror vibrations, pump lamp intensity fluctuations, etc. In accordance with this invention, we circumvent the instability problem by detecting the onset of relaxation oscillations and using this to trigger the opening of the Q-switch. " (Column 1 line 68 – Column 2 line 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use the detection onset of a relaxation pulse to send a signal to the Q-switch of Dane's ring laser.

7. Claims 19 and 37 rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Lee et al. (US 4,803,694).

As for claim 19, Dane discloses all that pertains to claim 1, as shown above. However Dane does not disclose using an aperture within the apparatus to allow a single transverse mode. Lee discloses, "To operate lasers in the fundamental (single) mode (i.e. TEM.sub.00 or Gaussian mode), an aperture is usually formed in the resonator to prevent oscillations of higher-order modes." (Column 1 lines 26-29). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use an aperture that allows a single transverse mode in Dane's ring laser to prevent higher-order mode oscillations.

As for claim 37, Dane discloses all that pertains to claim 22, as shown above. However Dane does not disclose using a transverse mode-limiting aperture. Lee discloses, "To operate lasers in the fundamental (single) mode (i.e. TEM.sub.00 or Gaussian mode), an aperture is usually formed in the resonator to prevent oscillations of higher-order modes." (Column 1 lines 26-29). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use an aperture that allows a single transverse mode in Dane's ring laser to prevent higher-order mode oscillations.

8. **Claims 21 and 34** rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Smith et al. (US 6,282,224).

As for claim 21, Dane discloses all that pertains to claim 1, as shown above. However Dane does not disclose using components acting as an optical diode. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator which acts as an optical diode to Danes ring laser to not waste the pumping energy.

As for claim 34, Dane discloses in Fig. 1, shown below, A laser system, comprising: a laser resonator (shown as resonator in fig 1 below), comprising an output coupler (labeled as a polarizing beam splitter) a Q-switch (labeled as a Pockels cell in

fig 1) in the resonator; a gain medium (labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2) in the resonator; a source of energy (see description of fig 5, a flash lamp is interpreted as a source of energy), coupled with the gain medium, to pump the gain medium (see figure 5, shown below); a detector (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-23), coupled with the resonator, to detect oscillation energy in the resonator; and a controller, coupled to the source of energy, the Q-switch and the detector, to set conditions inducing loss in the resonator at a level allowing build up of gain in the gain medium to produce a relaxation oscillation pulse, and to decrease loss in the resonator in response to detection of the relaxation oscillation pulse, so that an output pulse having a single frequency is generated (described by Dane on Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-24, which reads " The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation, the Q-switch is opened. "). However Dane does not disclose using components acting as an optical diode. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator which acts as an optical diode to Danes ring laser to not waste the pumping energy.

9. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Caprara et al. (US 6,198,756). Dane discloses all that pertains to claim 22. However, Dane does not disclose adjusting the length of the optical ring. Caprara discloses "Mirror 84 is driven by a piezoelectric driver 90 or the like to maintain ring-resonator 82 in a resonant condition for radiation S by actively adjusting the path length for radiation S in the ring-resonator." (Column 8 lines 1-4). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use a piezoelectric driver for adjusting the ring length to maintain a resonant condition. The Examiner wishes to point out that if one of the mirrors were driven by a driver; that would change the angle of reflection on that mirror.

10. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Smith et al. (US 6,282,224) and Ammann et al. (US 6,282,224). Dane discloses, In figure 1 shown below, A laser system, comprising: a laser resonator (**emphasis added on figure 1 to show what the examiner is considering a resonator**) arranged as an optical ring (in fig 1 the shape is an optical ring, it uses the same path and direction for multiple passes), comprising a polarizer (labeled as a Pockels cell) and a polarizing beam splitter (labeled as polarizing beam splitter in the fig.) arranged as an output coupler; a Pockels cell (labeled as Pockels cell in the fig.) in the resonator; a gain medium in the resonator(labeled gain medium in fig 1

shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2); a source of energy (see description of fig 5, a flash lamp is interpreted as a source of energy), coupled with the gain medium, to pump the gain medium (see description of fig 5, a flash lamp is interpreted as a pump source); a detector (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-23, which reads, "The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror... "), coupled with the resonator, to detect oscillation energy in the resonator; and a controller, coupled to the source of energy, the Pockels cell (labeled as Pockels cell in fig 1) and the detector, to set conditions inducing loss in the resonator at a level allowing build up of gain in the gain medium to produce a relaxation oscillation pulse, and conditions decreasing loss resonator using the Pockels cell in response (described by Dane on Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-24, which reads " The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation, the Q-switch is opened. "), so that an, and applying an adjustable voltage to the Pockels cell to adjust polarization within the resonator and thereby reflectivity of the polarizing beam splitter arranged as the output coupler (see pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph lines 16-19), to set a pulse width during said conditions decreasing loss. Dane further discloses," By placing a frequency selective element such as an etalon in the cavity, this long build up time and the corresponding many passes through the etalon results in single longitudinal mode oscillation " (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph lines 18-21). However Dane

does not disclose detecting the onset of the relaxation oscillation or the use of an optical diode in the resonator. Ammann discloses, "In general, however, there are pulse to pulse variations in the buildup time due to laser mirror vibrations, pump lamp intensity fluctuations, etc. In accordance with this invention, we circumvent the instability problem by detecting the onset of relaxation oscillations and using this to trigger the opening of the Q-switch. " (Column 1 line 68 – Column 2 line 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use the detection onset of a relaxation pulse to send a signal to the Q-switch of Dane's ring laser. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator, which is as an optical diode, to Dane's and Amman's ring laser to not waste the pumping energy.

11. Claim 43 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Smith et al. (US 6,282,224). Dane discloses, in figure 1, shown below, a method of operating a laser to obtain an output pulse of laser radiation having a single wavelength, the laser including a resonator arranged as an optical ring (in fig 1 the shape is an optical ring, it uses the same path and direction for multiple passes), a gain medium (labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2) positioned

inside the resonator and a pump source, the method comprising: using a polarizing beam splitter (labeled as polarizing beam splitter in fig 1) as an output coupler; setting polarization inside the resonator to induce an intracavity loss into the resonator (There is a loss in the resonator because it is no output a beam during the buildup stage), the loss being an amount that prevents oscillation during a time that energy from the pump source is being stored in the gain medium (**see pg 151 II Optical Architecture: D. Single Frequency Oscillator, 2nd paragraph, lines 1-3, if there is no oscillation then there is a loss**); building up gain with energy from the pump source in the gain medium until formation of a single-frequency relaxation oscillation pulse in the resonator (see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, line19-26); and changing polarization inside the resonator to reduce the intracavity loss induced in the resonator and to set a reflectivity of the polarizing beam splitter upon the detection of the relaxation oscillation pulse so that built-up gain stored in the gain medium is output from the resonator as a output pulse at the single frequency having a pulse width determined by the changed polarization (described on Pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19, "The <half wave> voltage is applied to the Pockels cell as the injected seed pulse is transmitted into the ring, canceling its passive 90 rotation … the Pockels cell voltage is switched back to zero … and is transmitted through the input polarizing beam splitter."). Dane further discloses, "By placing a frequency selective element such as an etalon in the cavity, this long build up time and the corresponding many passes through the etalon results in single longitudinal mode oscillation " (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph lines 18-

21). However Dane does not disclose using an optical diode inside the ring. Ammann discloses, "In general, however, there are pulse to pulse variations in the buildup time due to laser mirror vibrations, pump lamp intensity fluctuations, etc. In accordance with this invention, we circumvent the instability problem by detecting the onset of relaxation oscillations and using this to trigger the opening of the Q-switch. " (Column 1 line 68 – Column 2 line 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use the detection onset of a relaxation pulse to send a signal to the Q-switch of Dane's ring laser. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator, which is as an optical diode, to Dane's and Amman's ring laser to not waste the pumping energy.

Claim Rejections - 35 USC § 103-New Claims

12. Claims 34, 41, 57 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dane et al. ("Design and Operation of a 150 W Near Diffraction-Limited Laser Amplifier with SBS Wavefront Correction") in view of Smith et al. (US 6,282,224).

As for claim 34, Dane discloses in Fig. 1, shown below, A laser system, comprising: a laser resonator (shown as resonator in fig 1 below), comprising an output coupler (labeled as a polarizing beam splitter) a Q-switch (labeled as a Pockels cell in

fig 1) in the resonator; a gain medium (labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2) in the resonator; a source of energy (see description of fig 5, a flash lamp is interpreted as a source of energy), coupled with the gain medium, to pump the gain medium (see figure 5, shown below); a detector (Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-23), coupled with the resonator, to detect oscillation energy in the resonator; and a controller, coupled to the source of energy, the Q-switch and the detector, to set conditions inducing loss in the resonator at a level allowing build up of gain in the gain medium to produce a relaxation oscillation pulse, and to decrease loss in the resonator in response to detection of the relaxation oscillation pulse, so that an output pulse having a single frequency is generated (described by Dane on Pg 150, II. Optical Architecture: D. Single Frequency Oscillator, 1st Paragraph, lines 21-24, which reads " The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation, the Q-switch is opened. "). However Dane does not disclose using components acting as an optical diode. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator which acts as an optical diode to Danes ring laser to not waste the pumping energy.

As for claim 41, Dane discloses in Fig. 1, shown below, wherein the output

coupler comprises a polarizing beam splitter (labeled as a polarizing beam splitter), and including a polarization rotation element (a Pockels cell, labeled as Pockels cell in the figure) in the resonator to set an amount of light that is transmitted by the polarizing beam splitter during build up of gain (see pg 151 II Optical Architecture: D. Single Frequency Oscillator, 2nd paragraph, lines 3-6).

As for claim 57, A method of operating a laser to obtain an output pulse of laser radiation having a single wavelength (see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, lines 24-26 "The low power single frequency flux..."), the laser including a resonator (the resonator is being interpreted as being bound by the mirrors shown in the fig 1 shown below, labeled as resonator) *with an output coupler* (in fig 1 it comprises a polarizer, labeled as polarizing beam splitter, and a Pockels cell, labeled as a Pockels cell), a gain medium (labeled gain medium in fig 1 shown below, and supported on page 150 II. Optical Architecture. 1st Paragraph lines 1-2) positioned inside the resonator and a pump source (see description of fig 5, a flash lamp is interpreted as a pump source), the method comprising: inducing an intracavity loss into the resonator (There is a loss in the resonator because there is no output a beam during the buildup stage), the loss being an amount that prevents oscillation during a time that energy from the pump source is being stored in the gain medium (see pg 151 II Optical Architecture: D. Single Frequency Oscillator, 2nd paragraph, lines 1-3, if there is no oscillation then there is a loss); building up gain with energy from the pump source in the gain medium until formation of a single-frequency relaxation oscillation

pulse in the resonator (see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, line19-26); and reducing the intracavity loss induced in the resonator upon the detection of the relaxation oscillation pulse, so that built-up gain stored in the gain medium is output from the resonator as an output pulse at the single frequency (see pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, lines 21-26). However Dane does not disclose using components acting as an optical diode. Smith discloses "...it is difficult and inefficient to combine the two <beams traveling in opposite directions> to obtain the full power of the laser and to use only one direction output is to waste a substantial portion of the developed laser energy. To combat this a magnetic controller or Faraday rotator or other form of optical diode may be used. " (Column 6 lines 17-22). Therefore it would have been obvious at the time of the invention to one of ordinary skill to use a Faraday rotator which acts as an optical diode to Danes ring laser to not waste the pumping energy.

As for claim 61, Dane discloses in Fig. 1, shown below, wherein the resonator comprises a ring having an odd number of reflectors. The figure shows a resonator with 7 reflectors, numbering added to show how the Examiner is counting the reflectors.

13. Claims 60 and 64 rejected under 35 U.S.C. 103(a) as being unpatentable over Hackel (US 5022033) in view of May (2002/0041611).

As for claims 60 and 64 Hackel discloses all that pertains to claims 34 and 57 (see above). Hackel further discloses, restricting oscillation in the resonator to a single longitudinal mode using one or more etalons 18 placed at or near normal incidence

(Hackel discloses in figs. 2 and 3, the etalons approximately 90°, at or near normal); suppressing reflections from the one or more etalon (4/53-61). However Hackel does not explicitly disclose controlling the temperature of the etalon. May discloses, "The wavelength-locking controller thereafter monitors the temperature of the etalon and keeps the temperature constant to prevent any wavelength drift in the etalon." (Abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to control the temperature of the etalon to avoid wavelength drift.

Response to Arguments

14. Applicant's arguments filed 2/17/06 have been fully considered but they are not persuasive.

1. The Examiner addressed the limitations of claims 1, 22, and, 23 in the original office action dated 12/1/05 (See pages 4, 8 and 9).

2. The Examiners does include, "*at least the limitations of claim 43, <including> "Building up gain ... until formation of a relaxation oscillation pulse in the resonator.'"*(pg 18 of arguments dated 2/17/06) and the rest of the limitations (See page 19 of the Office Action dated 12/1/2005)

3. The examiner defined the defined the resonator for examination purposes as "the resonator is being interpreted as being bound by the mirrors shown in the fig 1 shown below, labeled as resonator", therefore the allegations that the examiner characterized the multipass amplifier as the resonator are moot.

4. The argument about the gain medium used in the reference, Dane et al. discloses (as pointed out on pg. 4-5 of the Office action dated 12/1/05), "The regenerative *amplifier* optical configuration *is ideally* suited to solid state gain media such as *Nd:glass*." (page 150 II. Optical Architecture. 1st Paragraph lines 1-2; italics added)

5. The definition for resonator was obtained from Elsevier, see attached. However a narrower definition can be used and the claims are still anticipated. The examiner notes that he did not define the gain medium alone as the resonator (See pages 4 and 21 of Office Action dated 12/1/05)

6. Light is a series of electromagnetic waves; waves inherently oscillate (See definition of "wave" from Penguin via xreferplus obtained at http://www.xreferplus.com/entry.jsp?xrefid=1442008&secid=.-&hh=1; on 5/15/06), therefore the amplifier, which amplifies the light, would oscillate.

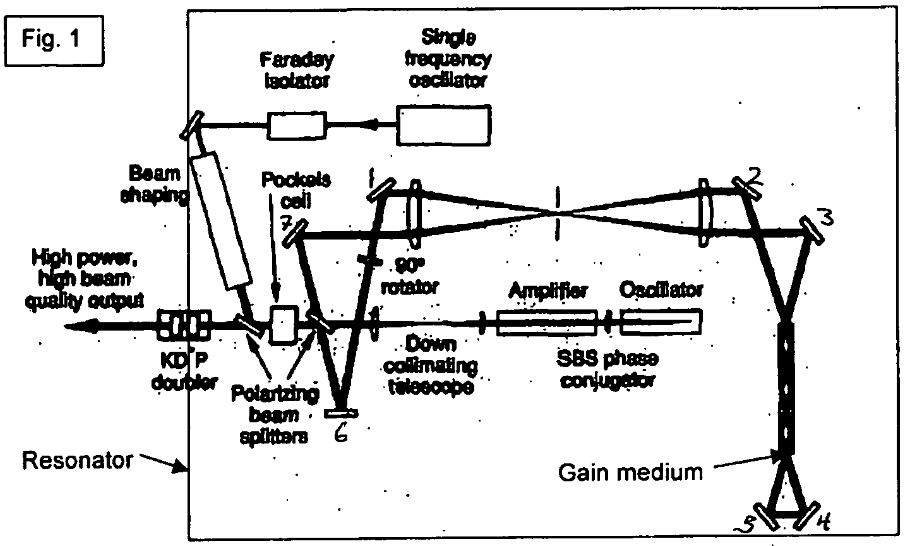
7. Dane discloses, "The intracavity power is monitored by the leakage through the high reflectivity (HR) mirror and when it peaks in a weak relaxation oscillation the Q-switch is opened" (pg 150 II Optical Architecture: D. Single Frequency Oscillator, 1st paragraph, lines 21-24). Which would mean that there is a pulse in the resonator, as a whole, which is what the claim requires.

8. As for the rejections made under 35 USC 103 (a) for claims 5, 31, 16-18, 32, 33, 19, 37, and 36. There was no argument made except that the attorney disagreed with the rejections of independent claims 1 and 22, addressed above.

9. None of the originally filed claims 1-43 explicitly required the pulse to be "seeded" (claims 44-56 are canceled), however the limitation is addressed by Dane et al. (See pg 150, II. Optical Architecture: C. Operation With an SBS Conjugator, 1st Paragraph, lines 13-19)

10. As for the argument against the combination of Dane and Smith, the addition of an optical diode would not render the Laser of Dane et al. inoperable because Dane et al. discloses "When the laser system is operated as a conventional regenerative amplifier system without SBS phase conjugation, an input pulse from the oscillator enters the system by a reaction off of a polarizing beam splitter placed in the ring as shown in Fig. 1. Although the optical layout shown in Fig. 1 is that for the phase conjugated system, **only minor differences** exist between the layout for conventional unidirectional operation. The Pockels cell moves from its position in Fig. 1 to a position **inside the amplifier optical ring**, replacing the 90' quartz rotator... During the first ring revolution, the half wave voltage is applied to the Pockels cell crystals so that further polarization rotation is prevented and **the input pulse is trapped in the regenerative amplifier ring until the voltage is removed**." (pg 149 II. Optical Architecture. B. Unidirectional Uncorrected Operation, 1st Paragraph lines 1-2) Therefore Dane discloses the laser is an "optical ring amplifier" with a single direction. Therefore the addition of an optical diode would not render the laser of Dane et al. inoperable, and the rejection is proper.

Fig. 1



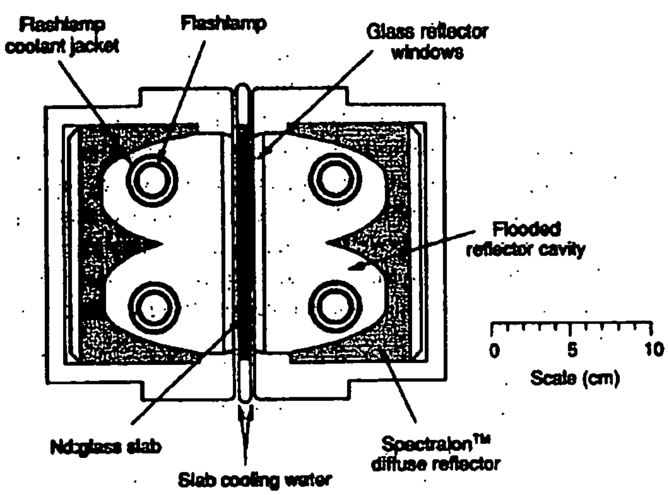


Fig. 5. A schematic illustration of the amplifier head design. The diffuse flashlamp reflectors are shaped from solid pieces of Spectralon™ and the Nd:glass slab is cooled by 3 l/s water flow through 2.5 mm channels on each side of the slab.

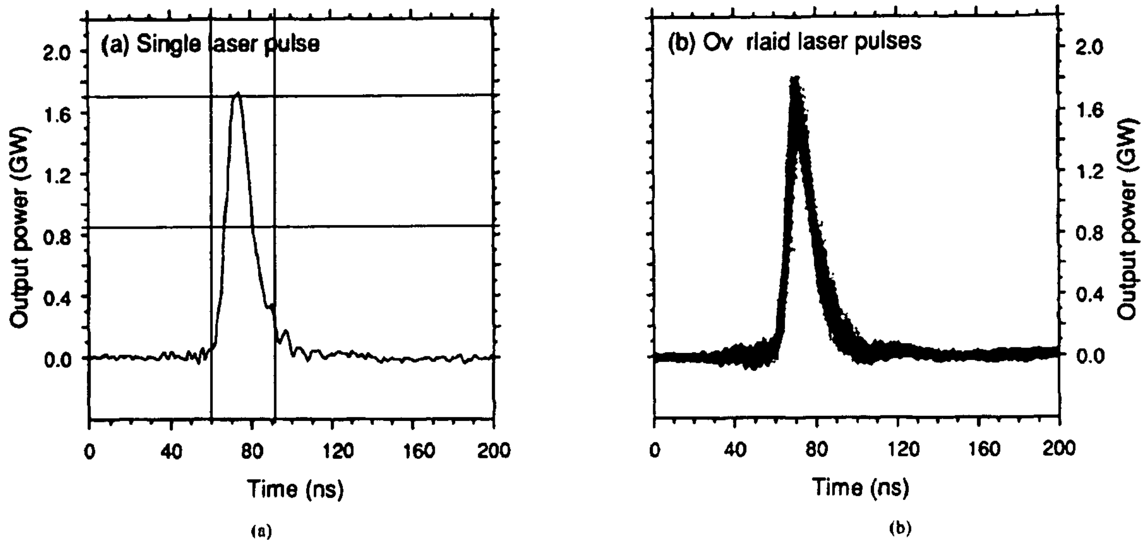


Fig. 15. The plot of (a) a single temporal waveform as well as (b) that of 1800 superimposed waveforms collected at 4 Hz. The overlaid pulses were accumulated in the infinite persistence mode of a digital storage oscilloscope.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. US 7003004 discloses a ring resonator with etalons and optical diodes.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey D. Lane whose telephone number is (571) 272-1676. The examiner can normally be reached on Monday thru Friday 8:30 to 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Minsun Harvey can be reached on (571) 272-1835. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jeffrey Lane

Jeffrey D Lane
Examiner
Art Unit 2828

JDL